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Mobilization of Vitamin E to the Lung under Oxidative Stress[a]

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Vitamin E is a fat-soluble vitamin with many proven and attributed functions. After almost 60 years of research, its mechanism of action and its requirement in humans remain controversial. One function that is generally accepted is its ability to act as a biological antioxidant[1] and free radical quencher capable of breaking chain reactions, thus protecting from oxidative damage. There is now increasing evidence that vitamin E plays an important role in the cellular antioxidant defenses against environmental stresses, such as air pollution and carcinogens.

For a number of years, we have studied the antioxidant properties of vitamin E in the lung and its ability to protect against oxidant air pollutants, namely, nitrogen dioxide (NO_2) and ozone (O_3).[2-4] We have reported previously that lung vitamin E content increased significantly after NO_2 or O_3 exposures,[2,4] and we have postulated that vitamin E may have been mobilized to the lung under oxidative stress possibly by a mechanism similar to that suggested by Kitada *et al.*[5,6] This increase in lung vitamin E content after oxidative stress was also reported by other investigators using NO_2 and tobacco smoke.[7,8]

To test this postulate, pregnant rats, 10 days from term, were fed a vitamin E-deficient diet. The offspring were fed the same deficient diet. After 8 weeks, half of the rats were supplemented with vitamin E (1000 IU/kg) for 2 additional weeks, and the other half continued to receive the deficient diet. One hour before exposure to O_3, both vitamin E-supplemented and -deficient rats were injected ip with ^{14}C-labeled *dl*-α-tocopheryl acetate (10 μCi/rat) and exposed to 0.5 ppm O_3 for 5 days. After exposure, vitamin E content and uptake were evaluated in seven rat organs. In general, vitamin E content reflected the dietary level, but the uptake was greater in deficient rats independent of the oxidative stress, possibly reflecting relative saturation of the supplemented rats with the vitamin. The relative (ozone/air) values of vitamin E content were not markedly altered after exposure, except in the lungs (TABLE 1), where it decreased in deficient rats, but increased in supplemented rats. The relative uptake increased in all organs, except for adipose tissue of both dietary groups and brain of supplemented rats, where it decreased. In the lungs, the relative uptake increased in both groups, but the increase was greater in supplemented rats (TABLE 1). The marked increase in lung vitamin E content and uptake after oxidative stress supports the concept of mobilization to the lung when the vitamin is sufficiently available in the body.

[a] This work was done in part at the University of California, Los Angeles.

TABLE 1. Effect of Exposure to 0.50 ± 0.05 ppm of Ozone Continuously for Five Days on Lung Vitamin E Content and [^{14}C]Vitamin E Uptake of Deficient and Supplemented Rats[a]

	Content (μg/g)		Uptake (dpm × 1000/g)	
	Deficient	Supplemented	Deficient	Supplemented
Air	0.34 ± 0.23	25.80 ± 3.33	17.81 ± 3.91	3.84 ± 0.33
Ozone	0.21 ± 0.04	34.81 ± 1.35	22.77 ± 3.41	9.49 ± 0.73
Change	−38%	+35%[b]	+28%	+147%[b]

[a] Dietary regimens are explained in the text. Results are expressed as mean ± SD, n=4.
[b] Significantly different from air; Student's t test, $p < 0.05$.

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